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(With four Figures.)

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(1) CHRYSOBERYL AND ASSOCIATED MINERALS, DOWERIN,
S.W.

Chrysoberyl was discovered in 1930 on block DAA 41, first in a boulder in the soil of a wheat field, and later *in situ* at a shallow depth. The associated minerals, in order of abundance, are eastonite (green black), a brown black mica, cummingtonite, and actinolite, with smaller quantities of almandine, andesine, quartz, schorl, magnesite, calcite (travertine), and apatite.

Chrysoberyl. This occurs in a mixture of black mica (eastonite), almandine, andesine and quartz, forming a small pipe at most 60 cm. (2 ft.) square in section, apparently at the crossing of two small vertical pegmatite veins which are accompanied by much micacised rock. The rock mass disclosed in the workings to a depth of 3 metres (10ft.) is a cummingtonite-black mica gneiss with narrow bands of bright green actinolite. The chrysoberyl has been found embedded in all four of the minerals forming its immediate matrix, viz. eastonite, andesine, almandine and quartz, but is most plentiful in the mica, especially in the vicinity of almandine nodules, where as many as four or five crystals have been counted in an area 2 cm. square.

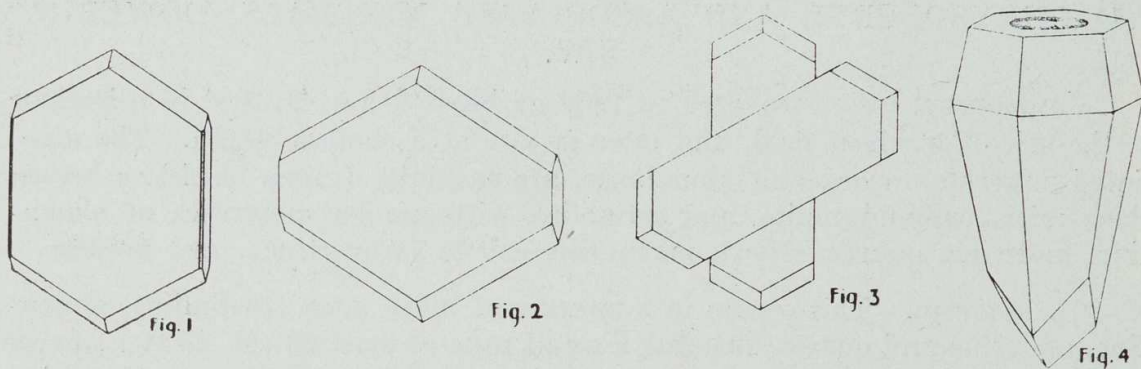
It appears in single scattered crystals, more or less perfectly developed, from 0.5 mm. in diameter up to the largest weighing 1.2 carats and measuring 10 x 4 x 2 mm. The crystals are usually tabular parallel to a (100), which face is not uncommonly vertically striated, and in one case shows an arrowhead striation due to repeated interpenetrating twinning on (031). The crystals are usually a combination of a (100), b (010) and o (111), Occasionally the edge ab is bevelled by the face m (110). Common forms are shown in Figs. 1 and 2. Fig. 3 represents a unique form of twin on

(031) in which two superimposed prisms are countersunk into one another to the extent of half their thickness. The angle measured under the microscope between the pyramid edges was 60° ; theory requires $60^\circ 26'$ (Hintze), $60^\circ 14'$ (Dana). The specific gravity determined by Clerici solution on a number of crystals was $3.70 \pm .02$.

All the smaller crystals are perfectly transparent and flawless, but the largest ones are turbid with inclusions of mica, etc., and are imperfectly developed. The clear crystals found so far have all been too small to cut into gems. The commonest colour is "fluorite green" (R. 33"), but some are a darker green, others lighter, whilst a few are a greenish yellow (R. 23" to 23" b) and still fewer almost colourless. Very rarely a crystal is darker green in the centre than in the periphery. A few of the deeper green crystals become violet-purple in artificial light, the peculiar colour change characteristic of alexandrite, and due to chromium being the colouring agent. Under the microscope the crystals show a straight extinction, and the observed pleochroism is:—

		Green Crystals.	Yellow Crystals.
X (a)	...	Pale greenish yellow, light green or rarely lilac ...	Pale yellow
Y (b)	...	Pale yellow or greenish yellow to colourless ...	Colourless
Z (c)	...	Emerald green to pale green	Greenish yellow

This is the first recorded occurrence of chrysoberyl in the State.



Figs. 1, 2, 3.—Chrysoberyl, Dowerin.

(1) Common type of crystal. Forms: a (100), b (010), m (110), o (111).

(2) Common type of crystal. Forms: a , b , o .

(3) Twin on (031). Forms: a , b , o .

Fig. 4.—Corundum crystal largely altered into Muscovite, with central core of unaltered Corundum. Forms: r (10-11), z (22-41).

Eastonite. A black mica is very abundant in one of the pegmatite veins, and in the gem bearing pipe. It is mostly bottle green (28'm. and lighter) in thin flakes, and almost uniaxial, $2E$ being not more than 3° . Some flakes are dark brown (9'm. and lighter) with a slightly larger optic axial angle, $2E$ about 5° ; other flakes are between these two in colour. The brown are probably derived from the green by oxidation. Very few pleochroic haloes were observed. The mineral is in coarse grained masses, with flakes from 2 or 3 mm. to occasionally several centimetres in diameter.

An analysis was made of carefully selected material from the gem-bearing pipe. It was almost all of the green variety, but some flakes were olive or brown. The results are given in the table. The molecular ratio Mg : Fe + Mn is 62 : 38, placing the mica in the phlogopite-eastonite series of the biotite group. A comparison of the molecular ratios of the Dowerin mineral with those of the two type minerals shows:—

	(OH,F)	K ₂ O	MgO	Al ₂ O ₃	SiO ₂
Phlogopite ...	4	1	6	1	6
Dowerin Mica ...	5	1	5.5	2	6
Eastonite ...	4	1	5	2	5

The Dowerin green-black mica therefore lies almost midway between the two species, but in the relative proportion of alumina is obviously nearer to eastonite. There is evidence of slight hydration due to surface alteration.

No details are available regarding the brown-black mica which is the common one in the gneiss, but which, judging from the specimens collected, is of rare occurrence in the pegmatitic material. It is probable that it only differs from the green mica in possessing somewhat more Fe₂O₃ and less FeO. As already stated, it possesses a slightly greater optic axial angle.

MINERALS ASSOCIATED WITH CHRYSOBERYL, DOWERIN.

	Eastonite.		Cumming- tonite.		Actinolite.		Andesine.		Almandine.	
	%	mols.	%	mols.	%	mols.	%	mols.	%	mols.
SiO ₂ ...	35.84	597	58.80	979	55.72	928	63.02	1049	37.23	620
Al ₂ O ₃ ...	16.68	163	Nil	—	.78	8	23.26	228	21.13	207
Fe ₂ O ₃ ...	4.14	26	trace	—	1.51	9	.10	—	trace	—
FeO ...	14.69	204	13.07	182	6.72	94	.22	3	31.33	436
MnO ...	.33	5	.69	10	.60	} 9	trace	—	3.41	48
NiO ...	Nil	—	Nil	—	.07		Nil	—	Nil	—
MgO ...	13.87	344	24.69	613	21.88	543	.35	9	4.09	101
CaO ...	Nil	—	.64	11	10.28	183	6.74	120	2.08	37
Na ₂ O ...	.48	8	Nil	—	.14	2	6.38	103	Nil	—
K ₂ O ...	8.48	90	Nil	—	.16	2	.40	4	Nil	—
H ₂ O + ...	4.24	255	2.50	138	2.11	117	.14	—	trace	—
H ₂ O — ...	.42	—	.02	—	.08	—	.07	—	Nil	—
Ti ₂ O ₃ ...	.36	3	...	—	...	—	trace	—	...	—
F ...	.96	51	...	—	...	—	...	—	...	—
Total ...	100.49		100.41		100.05		100.68		99.27	
O = F ₂ ...	.40									
Net total...	100.09									
G ...	3.00		3.06		3.05		2.67		4.18	
Analyst ...	D.G.M.		E.S.S.		D.G.M.		D.G.M.		H.P.R.	

Cummingtonite (Ferruginous Kupfferite). A coarsely crystallised, creamy-white, amphibole is absent from the pegmatite, but is the major constituent of the enclosing gneiss. The broader bands of this are composed of a mixture of cummingtonite and eastonite in the proportion of 2 or 3 to 1. Certain narrow bands, 0.5 to 1.0 cm. wide, consist practically wholly of this amphibole. The composition of material separated by methylene iodide between 3.05 and 3.10 is given in the table. It yields the formula H₂(Mg,Fe)₇Si₈O₂₄ with Mg : Fe + Mn = 76 : 24. This composition is

common to ferruginous kupfferite (cummingtonite), which is monoclinic, and ferruginous anthophyllite which is orthorhombic. Optical tests prove the Dowerin mineral to be monoclinic with an extinction angle $Z \wedge c = 15^\circ$ and the acute bisectrix parallel to X in the plane (010). Ng and Np are respectively 1.639 and 1.618. Under the microscope it is colourless and transparent, with prismatic cleavages making an angle of approximately 60° , and frequently exhibiting twinning on (100), sometimes multiple. It is coarsely prismatic or tabular in habit with prisms usually up to 5 or 6 mm. in length and 2 or 3 mm. in width, but occasionally in the pure veins it is in much larger tablets reaching 20 by 10 mm.

Actinolite. Certain narrow bands in the gneiss are conspicuous because of their bright green colour. These prove to be composed almost entirely of a nickeliferous actinolite ranging in tint from "sage" (R 29⁴) to "American" (33³ i) and "pistachio" green (33³). The masses are in long narrow bands and interbedded lenses from 1 to 20 mm. thick. The mineral is granular and glassy, the grains only loosely coherent. Under the microscope they are seen to be angular, 0.2 to 0.5 mm. in diameter, transparent and almost colourless to very pale yellowish-green. No typical structure is seen until the mineral is lightly crushed, when the prismatic cleavage yields tabular and prismatic granules. The basal plane shows up well in some of the latter, making an angle of 103° with the vertical axis. The mineral is monoclinic with a maximum extinction angle $Z \wedge c$ of 17° . The analysis given in the table yields figures approximating to the actinolite formula: $H_2Ca_2(Mg,Fe)_5Si_8O_{24}$.

The unusually bright green colour must be ascribed to the presence of nickel and ferrous iron together. It is worthy of note that the two monoclinic amphiboles, one lime-bearing, the other not, have crystallised separately in the rock, and not together to form a single species.

Andesine. Masses of a multiply-twinned felspar are rather common in the gem-bearing pipe and one of the micaceous pegmatite veins. They vary in colour from a dirty milk-white to glassy colourless, or with a faint tinge of grey or brown. Some of this glassy mineral is perfectly transparent in flakes several millimetres thick, and occurs in crystal individuals several centimetres in length and thickness, and usually showing under the microscope multiple twinning on (010) in very thin layers, with an extinction angle of 3° on a basal cleavage. The clearest mineral was analysed with the results shown in the table. These indicate a ratio of albite (plus microcline) to anorthite of 64 to 36, bringing the mineral within the subspecies andesine.

Almandine. This garnet is entirely confined to the gem-bearing pipe where it appears as large nodules, usually several centimetres in diameter and devoid of crystal faces. It sometimes encloses crystals of chrysoberyl. The garnet is translucent in layers of 0.5 to 3 mm. thick, and is of a brownish-red colour (R P i). An analysis is given in the table. The ratios of $RO : R_2O_3 : SiO_2$ are 623 : 207 : 620 which are extremely close to the theoretical ones of 3 : 1 : 3. The relative proportions of the different garnet molecules present are:

Almandine.	Spessartite.	Pyrope.	Grossularite.	Total.
70.0	7.7	16.3	6.0	100.0

This is the only iron magnesium silicate in the whole complex in which the iron preponderates over the magnesium.

Apatite. A mineral of rare occurrence in nodules and hexagonal prisms in the gem-bearing pipe has proved to be apatite. It is greyish-white, greenish-white, or faintly olive in colour, and varies greatly in translucency from completely transparent in a 3 mm. layer to faintly translucent in a 1 mm. layer. The specific gravity was found to be 3.20 and the mineral yielded the usual chemical reactions. Prisms ranged in size from 2 x 5 mm. to 7 x 15 mm. The smaller ones showed only *m* (10—10); larger one showed narrow faces also of *a* (11—20). The mineral is usually embedded in masses of eastonite.

Magnesite and Calcite. White porcelanous nodules of magnesite are scattered through the soil in the immediate vicinity of the chrysoberyl workings. In the open cut they are seen to arise from veins and strings of nodules in the weathered portion of the gneiss.

Jointed and dislocated fragments of the gneiss and pegmatite are often coated with a thin layer of travertine, the average rainfall (15 inches) and drainage in this district being insufficient to dissolve and carry away the whole of the less soluble products of rock weathering.

Quartz and Schorl. A small quartz-schorl pegmatite vein intersects a larger eastonite-andesine vein in the workings and the gem-bearing pipe appears to occur at their intersection.

Surroundings. The only outcrops appearing in the immediate vicinity are those of a large siliceous pegmatite and several dykes of different types of greenstone. It is probable that the cummingtonite-eastonite gneiss is a highly altered pyroxenite or hartzburgite. Granite is not far away in every direction.

(2) COLUMBITE AND TAPIOLITE, JIMPERDING, S.W.

The prospectors who have been obtaining a little alluvial and eluvial gold on a branch of Jimperding Brook have often obtained a small amount of heavy black gravel in their dish concentrates. Physical and chemical tests have proved much of this to be normal columbite.

The recognisable fragments of the mineral are from 3 to 10 mm. in length and tabular in habit. The heaviest piece was just under one gramme in weight. The faces, proved by measurements with a contact goniometer, are *a* (100), *b* (010), *c* (001), *u* (133); all of which are common. Only rarely are seen the faces *e* (021), *m* (110) and *z* (530). Groups are seen in which (1) all faces are parallel, (2) the (010) face is common to all subdivisions or parallel throughout, but the (100) faces differ in orientation by successive amounts of about 10°, giving a fan-shaped arrangement. The colour of the fragments is black with lustre sometimes dull, sometimes brilliant. The specific gravity of the largest crystal is 6.29, and that of ten small ones, averaging 0.1 gramme each, is 6.33.

An analysis of a small crystal gave the following results:—

COLUMBITE, JIMPERDING.

	Ta ₂ O ₅	Nb ₂ O ₅	FeO	MnO	Total.
Per cent. ...	44.5	38.0	13.5	4.0	100.0
Mols ...	101	142	188	56	

In one parcel of concentrate a single crystal of tapiolite (tetragonal FeTa_2O_6) was detected. It is 10 mm. long and weighs 0.95 gramme. The ends of the crystal are broken but the faces s^1 (111) s^2 s^3 s^4 are large and well preserved and a^1 (100) and a^3 (-100) small but distinct. Like many tapiolite crystals, this one is elongated parallel to the edge $s^1 s^2$. The measured angle between these two faces is 57° (calculated $57^\circ 0'$), and $a s$ $61^\circ 30'$ (calculated $61^\circ 25'$). The specific gravity was found to be 7.75, which, taken in conjunction with the crystallographic data, leaves no doubt as to the identity of the mineral.

A much smaller crystal, only 3 mm. in length, is also probably tapiolite. No density determination could be made but $s^1 s^2$ measured 57° .

(3.) CORUNDUM, LOWER CHITTERING, S.W.

In prosecuting his intensive search of the Chittering Valley for unusual minerals and rocks Mr. J. E. Wells has made an important discovery near the southernmost extension of those Precambrian schists, which at various other points in the valley have yielded kyanite, sillimanite and staurolite in abundance.*

Between the Bullsbrook Road and the confluence of the Chittering with the Swan, in an area where he had previously found sillimanite, kyanite and pseudomorphs of muscovite after andalusite, he has now discovered corundum. The exact position is about $1\frac{1}{2}$ miles east of C.G. 1260, near the summit of the range and on the south side of a gully which joins the main valley on that Crown Grant.

The corundum occurs only over a very small area, about 3 x 1 chains (60 x 20 metres) embedded in the outcrop of a narrow band of quartz-biotite schist flanked on either side by granite, which is succeeded in turn on the west by alternate bands of micacised andalusite schist and granite.

In this small outcrop corundum crystals have been quite common, until a later stage of intense metasomatism converted them into sericite, leaving however a core of unaltered corundum in the centre of many of the largest. Most of the individuals, which lie at all angles in the schist, are fairly well crystallised, and reach a maximum of 5 inches in length and one inch in diameter (13 x 2.5 cm.). The micacisation has not been sufficiently violent to destroy the outline which is that of a bipyramid z (2241) clearly terminated in some distances by the rhombohedron r (1011). Rough measurements gave:—

$z^1 z^4$	21°	Theory	$20^\circ 48'$
$z^1 z^2$	59°		$58^\circ 55'$
$r^1 r^2$	94°		$93^\circ 56'$

Composite crystals, of which there are a few, do not appear to be twins, but rather adventitious intergrowths. A cross section exhibits a hexagonal surface of grey, micro-sealy, obscurely radiating mica, with or without a central core of unaltered corundum. This core in some crystals is small and has a ragged boundary firmly adherent to the mica. In other crystals it is larger and perfectly circular or oval in cross section, parting readily and cleanly

* See this volume, pp. 75-82.

from the mica. (See Fig. 4, page 62.) The mica and core from such a crystal were examined separately in detail. The mica proved to be a barium-bearing muscovite as the following figures show:—

MUSCOVITE PSEUDOMORPH AFTER CORUNDUM, LOWER CHITTERING.

SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	MnO	CaO	BaO	MgO	Na ₂ O	K ₂ O
44.28	35.64	2.56	<i>Nil</i>	.28	1.16	.28	.36	10.34
H ₂ O	F	TiO ₂	Total	G.				
4.92	n.d.	.14	99.96	2.86				Analyst—D. G. Murray.

The core is brownish or purplish in colour, with a dull to subvitreous lustre. It has a specific gravity of 3.90 and a hardness of over 8. No and Ne are both over 1.733. In most cases the rhombohedral twinning and parting are obvious, the measured angle between the faces being 94°. The powder is transparent, and for the most part colourless; some fragments, however, are more or less deep blue, or partly blue and partly colourless. Thin films of limonite penetrate the natural partings and cracks. A partial analysis of a small chip showed Al₂O₃ (with traces of Fe and Ti) 95.72 per cent; SiO₂ 4.88 per cent.

This is the only corundum known west of Jacob's Well.

(4) DIOPSIDE, NEVORIA, CEN.

Basic pegmatites are not common in our Precambrian greenstones, so that the composition of one found at Nevoria is worth recording. On the dump of the Banker G.M. the writer found some large masses of amphibolite through which ran a pegmatite vein about a foot (30 cm.) in width. This was composed chiefly of large lamellar masses of a pyroxene, associated with smaller and finer grained masses of a dark green amphibole and occasional coarsely crystalline calcite.

The pyroxene proves to be a ferruginous diopside (salite), as the following analysis shows:—

	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	FeO	MnO	MgO	CaO	Na ₂ O
Per cent. ...	52.71	.98	1.28	5.77	.24	14.84	22.53	<i>Nil</i>
Mols. ...	877	10	8	80	3	368	402	—
	K ₂ O	H ₂ O+	H ₂ O—	TiO ₂	CO ₂	P ₂ O ₅	Total.	G.
	.08	.64	.22	.08	.18	<i>Nil</i>	99.55	3.26
	1	36	—	1	4	—		

These figures give the following molecular percentages:—

CaMgSi ₂ O ₆	...	...	...	73
Ca(Fe,Mn)Si ₂ O ₆	...	...	...	19
Mg ₂ Si ₂ O ₆	...	...	...	4
Mg(Al,Fe) ₂ SiO ₆	...	...	...	4
				100

The mineral is pale grey to grey green (near R29^b) in colour, and not pleochroic. It is very coarsely crystallised, with marked basal parting. The maximum extinction angle which was measured was 31°. Under the microscope a slight alteration to amphibole and chlorite is noticeable round the boundaries and along the cleavages of the crystals.

(5) MARGARITE AND CORUNDUM, GIBRALTAR AND NEVORIA, CEN.

Margarite has not previously been detected in this State, though many years ago found at Woodside in South Australia, and Mt. Read in Tasmania. This year it has been found in two places about 100 miles apart, viz., Gibraltar and Nevoria. In each case it is intimately associated with corundum.

Gibraltar.—The margarite from 2 miles south of the Gibraltar G.M. is in irregular groups of large (2 to 5 mm.) scales embedded in microgranular grey corundum. These larger scales are often grouped in imperfect rosettes, and the flakes in other groups are never parallel over a large area. They are greyish-white in colour and slightly less transparent and more brittle than muscovite. In one case what appears to be an imperfect hexagonal prism of corundum 30 mm. in diameter is entirely surrounded by a layer of radiating scales of margarite. Besides the larger scales there are innumerable smaller scales down to microscopic size scattered through the corundum.

An analysis made of some of the coarser mineral separated by CH_2I_2 gave the following results:—

MARGARITE, GIBRALTAR.								
		SiO_2	Ti_2O_3	Al_2O_3	Fe_2O_3	MnO	MgO	CaO
Per cent.	...	31.38	.10	48.98	1.55	.02	1.10	8.00
Mols.	...	522	1	481	10	—	27	143
		Na_2O	K_2O	$\text{H}_2\text{O}+$	$\text{H}_2\text{O}-$	Total.	G.	
Per cent.	...	3.14	.18	5.71	.11	100.27	3.04	
Mols.	...	51	2	318	6			

Such sodium-bearing margarites have been called Clingmanite, and are known from Madison, North Carolina; Unionville, Pennsylvania; Back Creek, South Island, New Zealand; Bynarka, Urals; Village Green, Pennsylvania; and Nicaria Island, Asia Minor. These carry respectively 6.15, 4.78, 4.74, 3.76, 2.97 and 2.86 per cent. of Na_2O . The soda-bearing molecule has not been worked out as yet. One would expect it to be the paragonite molecule $\text{H}_2\text{NaAl}_2\text{Si}_3\text{O}_{12}$, which differs only from the margarite molecule by the common substitution of NaSi for CaAl . This molecule does not, however, satisfy many of the analytical data.

Under the microscope the scales of the Gibraltar mineral are colourless and transparent, slightly birefringent, with the acute bisectrix almost perpendicular to the basal plane and a large optic axial angle in air. They are sometimes penetrated by small corundum crystals.

The 0.25 mm. concentrate of corundum from Gibraltar is pale grey in mass but colourless and transparent or translucent under the microscope. Among many angular fragments are a few imperfect crystals, all bipyramids. The largest crystal from the granular corundum rock was 2 mm. long. The mineral has a specific gravity (by Clerici solution) of 4.00, and a hardness of 8.5.

Nevoria.—The surface specimens obtained a little north of the Never Never G.M. are almost identical with those from Gibraltar except that the margarite is less abundant. Most of it is in coarse scaly bunches, pearly white in colour; there are fewer fine scales scattered through the dense granular grey corundum.

A qualitative analysis of the micaceous mineral proved the presence of SiO_2 , Al_2O_3 , CaO , MgO , Na_2O and H_2O . It has a specific gravity of 3.03, determined with CH_2I_2 on the fine powder. Scales under the microscope show a low birefringence on the basal plane, with a biaxial figure with rather large 2E. These results are typical of margarite.

The granular massive corundum varies from pale to dark grey in colour. One of the cleanest fragments has a specific gravity of 3.8, a low result for corundum due to microscopic pores and inclusions. Under the microscope it is transparent and mostly colourless, but occasional fragments or portions of fragments are sapphire blue in colour. No crystals were observed in the 0.25 mm. powder, but occasional prism and pyramid faces a few mm. long are to be seen on some of the hand specimens. The hardness is typical.

(6) REINITE AND SCHEELITE, JIMPERDING, S.W.

FeWO_4 occurs almost exclusively in nature in forms belonging to the monoclinic system, and known as ferberite. In 1878, however, some tetragonal crystals of this compound were found at Mt. Kimbo in Japan and described as a new species under the name of Reinite. Doubt has since arisen as to whether the tetragonal form is natural to FeWO_4 or only arises by replacement of crystals of scheelite (CaWO_4) by the corresponding iron compound. In this case reinite would not be an independent species.

In a quartz reef which was opened up in 1930 in search of gold in the Jimperding Valley, several tetragonal crystals of reinite were found which are undoubtedly merely pseudomorphs after scheelite, since in several of them part of the original yellow scheelite is plainly visible. The crystals range from 5 to 20 mm. in length and are simple unit bipyramids in form. Angles calculated and measured on the largest crystal are—

		p^1p^2	p^1p_1
Calculated	...	... $79^\circ 55'$	$49^\circ 27'$
Measured	...	... 80°	50°

This crystal weighed 6 grms. and had a specific gravity of 6.73 as compared with 6.10 for scheelite and 7.40 for ferberite.

Cross fractures show in most of the crystals a number of small remnants of yellow scheelite embedded in the brownish black reinite. The surface portions have been almost completely altered, scheelite only rarely showing in quite small areas.

Reinite does not appear to have been previously observed anywhere in the Commonwealth.

(7) VARISCITE (REDONDITE) AND LEUCOPHOSPHITE (Sp. nov.), NINGHANBOUN HILLS, S.W.

At the extreme eastern end of the Ninghanboun Hills, on the shore of Lake Weelhamby (a large salina), is a knoll of serpentine reaching to about 100 ft. above the lake level. The rock in this hill is extraordinarily dismembered by three sets of cracks approximately at right angles to one another,

and following the east and west cracks are two vertical veins about 2 ft. wide, passing over the summit of the hill about 30 ft. apart, and filled with a multicoloured mass of phosphates. The filling is not wholly confined to the two main seams, but extends from them for a greater or less distance into the other series of cracks, a considerable mass showing in a horizontal seam on the east side of the hill.

The veins are vughy or cavernous, some spaces being large enough to admit a man or a wallaby, a few of which obviously frequent them. On a smaller scale the filling is found to be porous, varying in texture from that of a hard or soft chalk to pumiceous, or crustiform with longitudinal crevices. The colour covers a wide range from almost pure white, through greyish-white and greenish-white to French green (R 35" i), Montpellier green (37" i) and nickel-green (37" m) in one direction, and through various tints of pinkish buff and lighter brown to hair-brown (R 17⁴ i) in another. Green is the more common colour.

Despite the apparent wide range of material contained in the veins, actual analysis shows the filling to be almost wholly redondite, a ferriferous variety of variscite, intimately mixed with granular chalcedony and opal. The varying colour appears to be due to uneven distribution of staining agents, chromium phosphate being responsible for the various shades of green, and iron and possibly manganese compounds for the buff and brown. The purest variscite, as well as that which contains appreciable quantities of isomorphous ferric phosphate, is apparently white.

A close examination of the structure of the filling reveals several stages in the deposition of the phosphates associated with corresponding colour variations. It is quite plain that much of the present filling is a replacement in situ of angular blocks of the serpentine, ranging in size from a few millimetres to many centimetres in diameter. In an excavation on the northern vein are exposed one or two large blocks of the dark green rock which were fresh in the centre but have been altered into a grey mixture of variscite and chalcedony to a depth of about a centimetre all round. Such a crust was found to contain 3.69 per cent. of P_2O_5 and 64.32 per cent. of silica. Other large boulders have been completely phosphatised, but show remnants of their original structure, particularly of a subfibrous actinolite. A typical specimen of this nature is mottled white, pale green and pale brown in colour, carrying in bulk 6.86 per cent. of P_2O_5 and 62 per cent. of silica and insoluble silicates. It is traversed by veinlets of dull green opal.

The brightest green material in the deposits is almost wholly in angular fragments, both small and large, and more rarely in lamellar, crustiform, masses. The angular masses, which are obviously replacements, are embedded in a porous mass of white or tinted material, which will be referred to as the matrix.

A third structural feature is the presence of a fair number of sharply defined veinlets in the matrix, from a millimetre or two, to one or two centimetres in width. The narrowest of these are often filled with opal, the wider ones with buff or brownish redondite, a typical veinlet carrying 27.55 per cent. of acid soluble P_2O_5 combined with alumina and iron, and contaminated with 23 per cent. of silica, no lime being present.

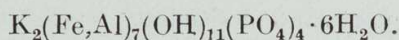
Dealing with the chemical composition of the vein filling it is to be remembered that variscite, $\text{AlPO}_4 \cdot 2\text{H}_2\text{O}$ and strengite, $\text{FePO}_4 \cdot 2\text{H}_2\text{O}$ are completely isomorphous, and a complete series of intermediate co-crystallisations are known. Of these the ferriferous varieties of variscite have been called redondite, and the aluminous varieties of strengite, barrandite. $\text{CrPO}_4 \cdot 2\text{H}_2\text{O}$ in small quantities is present in many occurrences.

One very white, chalk-like mass from the matrix, proved on analysis to be a mixture of granular chalcedony and a hydrous phosphate of potassium, iron and aluminium, the iron predominating over the aluminium. Its analysis is given in column 3 of the table. Such a mineral has not previously been recorded, though a related mineral is known, viz. minervite, a hydrous phosphate of potassium and aluminium with traces of iron replacing part of the aluminium. The formula of minervite is not definitely known, but may be approximately $\text{H}_2\text{KAl}_2(\text{PO}_4)_3 \cdot 7\text{H}_2\text{O}$.

A typical specimen of the new Ninghanboun phosphate taken for analysis was found to contain insoluble matter amounting to 55.33 per cent. made up as follows:—

	per cent.
Chalcedony, quartz and traces of combined SiO_2 ...	52.75
Chromite	1.07
Rutile ... ..	.48
Carbon, etc.	1.03

The remaining figures yield the formula:—



This compound is insoluble in water, but wholly soluble in hot strong HCl . In view of the large deductions and single analysis the formula is tentative. Neither can its physical properties be closely defined owing to its porosity and intimate contamination, but by heavy solutions its specific gravity has been shown to be between 2.30 and 2.65. In mass the mineral is white in colour and chalky in texture. Under the microscope it is minutely granular and birefringent and practically inseparable by eye or by heavy solutions from the accompanying granular chalcedony. As indicated above its minor contaminations are chromite, rutile, opal, carbonaceous matter, and possibly talc or serpentine. The type specimen is being divided between the British Museum, the Western Australian Museum and the writer's collections.

A second specimen of similar texture, by its mottled pale green tint merging into white, was plainly contaminated with chromiferous redondite, as well as with 46.9 per cent. of silica. It was found to contain, after rejecting the silica, P_2O_5 , 36.63 per cent.; K_2O , 4.65 per cent.; $(\text{NH}_4)_2\text{O}$, 0.04 per cent. This indicates a mixture of about 55 per cent. of the new mineral with 45 per cent. of redondite.

The presence of distinct traces of ammonia in the mineral is noteworthy. A second series of chips from the first analysed specimen gave 0.05 per cent. $(\text{NH}_4)_2\text{O}$ with only 38 per cent. of insoluble silica.

No previously described mineral approaches this in composition except minervite, a potassium aluminium phosphate, from which it differs in possessing a much greater basicity, a lower ratio of K to $(\text{Al} + \text{Fe})$, and finally a molecular preponderance of iron over aluminium. It appears therefore to be a new species for which the name Leucophosphite is suggested (Gr. *leukos*, white; *phosphoros*, the root of phosphate).

PHOSPHATIC MINERALS, NINGHANBOUN.

No. ... Mineral ... Colour ...	(1) Redondite. Brown.		(2) Redondite. Green.		(3) Leucophosphate. White.	
	%	mols.	%	mols.	%	mols.
Al ₂ O ₃ ...	17·81	175	20·45	201	12·73	125
Fe ₂ O ₃ ...	17·66	110	12·66	79	32·82	206
Cr ₂ O ₃ ...	tr.	—	·73	5	nil	—
FeO ...	·03	} 4	·20	3	nil	—
MnO ...	·27		nil	—	·22	3
MgO ...	·27		7	nil	—	·73	18
CaO ...	nil	—	nil	—	tr.	—
(NH ₄) ₂ O ...	tr.	—	tr.	—	·09	2
Na ₂ O ...	·19	3	tr.	—	·13	2
K ₂ O ...	·29	3	·96	10	7·88	84
H ₂ O + ...	19·82	1100	20·98	1164	12·28	681
P ₂ O ₅ ...	40·23	283	42·13	297	26·69	188
NiO ...	—	—	nil	—	tr.	—
CO ₂ ...	—	—	nil	—	·17	—
Carbon ...	nil	—	nil	—	tr.	—
SiO ₂ ...	1·92	—	nil	—	nil	—
TiO ₂ ...	·45	6	·21	—	nil	—
H ₂ O — ...	1·14	63	1·97	109	6·59	366
	100·08		100·35		100·33	
G ...	2·60	...	2·44	...	2·45 ±	...

Analyst—D. G. Murray.

- (1) After deducting 24·44% quartz and chalcedony, 0·45% rutile, 0·59% chromite.
 (2) After deducting 0·76% quartz and chalcedony, 0·20% rutile, 0·26% chromite.
 (3) After deducting 52·75% quartz and chalcedony, 0·48% rutile, 1·07% chromite, and 1·03% carbon, etc.

Apart from the two masses just described, all the other specimens collected from these veins proved on analysis to consist essentially of ferriferous variscite (redondite) contaminated with finely granular chalcedony and opal. Complete analyses were made of two very different looking specimens of the mineral. One was a large bright green (about 37" a) angular fragment picked out of a buff coloured matrix in the northern vein. The analysis is given in Col. 2 of the Table. The green colour is obviously due to the presence of CrPO₄·2H₂O. Other green specimens were partly analysed to confirm this impression, the figures obtained being:—

REDONDITE, NINGHANBOUN.

Colour :	Bright green.	Brown spotted with white and green.	Green and brown mottled.	Green, brown and white banded.
P ₂ O ₅ ...	37·93	12·72	39·07	36·50
Fe ₂ O ₃ ...	12·64	7·94	17·58	19·07
Cr ₂ O ₃ sol. in HCl ...	·71	·20	·53	·42
Cr ₂ O ₃ insol. in HCl ...	·31	·06	·37	·28
Insol. SiO ₂ , etc. ...	4·32	60·49	2·61	5·56

In each instance the insoluble Cr_2O_3 was shown to be present as granular chromite, a mineral found throughout the serpentine mass.

The other specimen analysed (Col. 1) was portion of a hair-brown, hard, slightly scoriaceous mass forming a lens in the southern vein. This also proved to be redondite, but differed from the green mineral in containing more iron as well as a little manganese and magnesia. No acid soluble chromium was present, but fine granules of chromite were distributed through the mass as in all the other specimens analysed. A section made of this material discloses a greenish brown base of minutely granular birefringent redondite in which are set rounded grains of phosphatised rock with angular and rounded quartz grains and black chromite, as well as an occasional cavity filling of chalcedony.

The small amount of acid soluble potash in both (1) and (2) suggests the presence of a small proportion of the new mineral leucophosphite in intimate association with the variscite.

The problem of the origin of the veins presents many points of interest. The nature of the enclosing rock, the many evidences of replacement of it by the vein filling, and the absence of lime, rule out sedimentary beds of organically derived apatite, or crystalline veins or pockets of apatite of the Canadian or Norwegian type. An origin to be considered is a vein or veins of pegmatite carrying such phosphatic minerals as amblygonite, childrenite, triphylite or zwieselite. Such minerals are, however, invariably associated with considerable quantities of coarsely crystallised quartz, felspar, mica, etc., no remnants of which, or of possible pseudomorphs after them, could be seen at Ninghanboun.

The Author's explanation is as follows:—

In recent geological times Weelhamby Lake was a lake in fact as well as in name, and carried abundant living organisms, fish, crustacea, etc., attractive to such birds as cormorants. The serpentine hillock, right on the water's edge, having a wide outlook, and being almost barren of soil and vegetation, formed a convenient roosting ground for large flocks of such birds. Their guano collected on the surface of it and in solution and suspension was carried into the numerous cracks in the rock, particularly into two which were rather larger than the others and reached to the very summit of the hillock. The chemically active ammonium phosphate of the guano attacked the susceptible serpentine, chlorite and other silicates of the rock, producing as the end product of a series of reactions, the highly stable aluminium-iron phosphate redondite in the form of replacement veins and fissure fillings.

The arguments in favour of this theory, apart from its inherent possibility, and the previously stated arguments against a derivation from the normal apatite bed or vein, or a phosphatic pegmatite, are the following:—The abundant evidence of the replacement of the serpentine rock owing to attack by a soluble phosphate. This evidence is both structural and constitutional, especially the presence of pseudomorphs after amphibole and visible partial and complete replacements of masses of the serpentine rock. Again there is the regular distribution of granules of chromite through all the specimens examined. Another point of evidence is the presence, in all specimens, of angular and rounded granules of quartz and rarely microcline, both foreign to the matrix but such as might be carried to their roost by the

birds on their feet. Furthermore, distinct traces of ammonia were detected in such specimens as were examined for it. Finally, certain obscure structures in the veins appear to be chalcedony or opal pseudomorphs after fragments of mollusc shells. It is to be noted that the redondite of Martinique and Redonda Is. is considered to have been produced by the action of guano on andesite; that of Clipperton Is. by similar action on trachyte; the variscite of Connetable Is. from the same action on amphibolite; and the minerite of Reunion Is. from the same action on basalt.

SUMMARY.

A description is given of the occurrence and physical and chemical properties of (1) Chrysoberyl and associated minerals (Cunningtonite, etc.) at Dowerin, this being the first record of Chrysoberyl in the State; (2) Columbite and Tapiolite at Jimperding; (3) Corundum in the Lower Chittering Valley; (4) Diopside at Nevoria; (5) Margarite and Corundum at Gibraltar and Nevoria, the first record of Margarite in the State; (6) Reinite and Scheelite, Jimperding, the first record of Reinite in the State; (7) Variscite and Leucophosphite (a new hydrous phosphate of potash and iron) at Ninghanboun, the first record of both in the State.